CLAIMS

1. A display device for generating a three-dimensional volumetric image, comprising:

a two-dimensional image display panel (41, 46) for generating a two-dimensional image;

a first focusing element (42, 47) for projecting the two-dimensional image to a virtual image (40, 45) in an imaging volume (44, 49); and

means (43, 48, 50, 51, 60) for altering the effective optical path length between the display panel and the projecting first focusing element so as to alter the position of the virtual image within the imaging volume.

2. The display device of claim 1 in which the means (43, 48, 50, 51, 60) for altering the effective optical path length is adapted to operate so as to move the virtual image periodically through the imaging volume.

3. The display device of claim 2 further including:

a display driver (72) for controlling the display panel to generate a succession of different images as the virtual images corresponding thereto are moved through the imaging volume; and

control means (73, 74) for synchronising the display driver with the means (70) for altering the effective path length.

4. The display device of claim 1 in which the means for altering the effective optical path length comprises a second focusing element (43, 48) having adjustable optical strength.

5. The display device of claim 4 in which the second focusing element (43, 48) is a liquid crystal adaptive lens.

6. The display device of claim 4 in which the second focusing element (43, 48) is a deformable lens.

7. The display device of claim 4 in which the second focusing element (43, 48) is a deformable mirror.

8. The display device of claim 1 in which the means for altering the effective optical path length comprises physical displacement means (70b) for altering the relative positions of the display panel (46) and the first focusing element (42, 47).

9. The display device of claim 1 in which the means for altering the effective optical path length comprises an optical path modifier (50, 51, 60) for varying at least a portion of the optical path between the display panel (46) and the first focusing element (42, 47).

10. The display device of claim 9 in which the optical path modifier (50, 51) is adapted to vary a distance travelled by the light from the display panel (46) to the focusing element (42, 47).

11. The display device of claim 9 in which the optical path modifier (50, 51, 60) is adapted to vary the refractive index of at least a portion of the optical path.

12. The display device of claim 10 or claim 11 in which the optical path modifier comprises a plurality of displaceable refraction elements (50, 51) for displacing and thereby varying the length of a portion (53) of the optical path.

13. The display device of claim 10 in which the optical path modifier is a reflective element (60) having a plurality of portions of differing height which may be selected to reflect the light from the display panel to the focusing element from different physical locations; and

selection means (66) for varying the portion of optical element that lies in the optical path.

14. The display device of claim 11 in which the optical path modifier (60) comprises:

an optical element (60) between the display panel (46) and the first focusing element (47), having a different refractive index than other parts of the optical path between the display panel and the first focusing element, the optical element having portions (60 – 64) of varying thickness and/or refractive index; and

selection means (66) for varying the portion of optical element that lies in the optical path.

15. The display device of claim 1 in which the first focusing element (42, 47) enlarges the virtual image (40, 45) of the display panel (41, 46).

16. The display device of claim 1 in which the first focusing element (42, 47) projects the two dimensional image into a corresponding planar virtual image (40, 45) in the imaging volume (44, 49), the means for altering the effective path length altering the distance of the planar virtual image from the optical output of the first focusing element (42, 47).

17. The display device of claim 1 in which the display panel (41, 46) is adapted to have an image refresh rate substantially greater than 50 frames per second.

18. The display device of claim 1 in which the display panel (41, 46) is adapted to have an image refresh rate greater than 200 frames per second.

19. The display device of claim 1, claim 2 or claim 3 in which the means for altering the effective optical path length includes mechanical means.

20. The display device of claim 1, claim 2 or claim 3 in which the means for altering the effective optical path length includes electro-optical means.

21. The display device of claim 1 in which the first focusing element is a single or compound element having substantially a single focal length.

22. The display device of any one of claims 4 to 6 in which the second focusing element is an adjustable, single or compound lens having a substantially constant focal length over its entire working area.

23. A method of generating a three-dimensional volumetric image, comprising the steps of:

generating a two-dimensional image on a two-dimensional image display panel (41, 46);

projecting the two-dimensional image to a virtual image (40, 45) in an imaging volume (44, 49) with a first focusing element (42, 47); and

altering the effective optical path length between the display panel and the projecting focusing element so as to vary the position of the virtual image within the imaging volume.

24. The method of claim 23 including moving the virtual image periodically through the imaging volume.

25. The method of claim 24 further including the steps of:

controlling the display panel to generate a succession of different images as the virtual images corresponding thereto are moved through the imaging volume; and

synchronising the images of the display panel with the periodic movement of the virtual images through the display volume.

26. The method of claim 23 in which the step of altering the effective optical path length comprises varying the optical strength of a second focusing element (43, 48).

27. The method of claim 23 in which the step of altering the effective optical path length comprises altering the relative positions of the display panel (46) and the first focusing element (42, 47).

28. The method of claim 23 in which the step of altering the effective optical path length comprises varying at least a portion of the optical path between the display panel (46) and the first focusing element (42, 47).

29. The method of claim 28 further comprising varying a distance travelled by the light from the display panel (46) to the focusing element (42, 47).

30. The method of claim 28 further comprising varying the refractive index of at least a portion of the optical path.

31. The method of claim 29 or claim 30 further comprising varying the positions of a plurality of displaceable refraction elements (50, 51) for displacing and thereby varying the length of a portion (53) of the optical path.

32. The method of claim 29 further comprising the step of introducing a succession of mirrors into the optical path, each mirror having a different position with respect to an incident optical beam.

33. The method of claim 30 further comprising altering the position of an optical element (60) between the display panel (46) and the first focusing element (47), having a different refractive index than other parts of the optical path between the display panel and the first focusing element, the optical element having portions (60 – 64) of varying thickness and/or refractive index.

34. The method of claim 23 further including the step of refreshing the image in the display panel at a refresh rate substantially greater than 50 frames per second.

35. The method of claim 34 in which the step of refreshing the image in the display panel is at a refresh rate greater than 200 frames per second.